Hydraulic Design Guidance for Locks and Dams

Problem

To ensure safety, the design of a lock and dam system requires accurate estimation of the hydraulic performance. Of the different lock components (intakes, valves, gates, culverts, outlets, etc.), none has more impact on providing rapid locking operations and safe navigation conditions than the manifolds that directly fill and empty the lock chamber. Currently, performance evaluation requires large-scale hydraulic models. Construction of physical models is very time consuming and expensive. The use of numerical modeling in place of physical modeling will decrease hydraulic evaluation costs and time. The primary consequence of not conducting this research is that design ideas will be limited to those that have resources to support a physical model study. This could greatly hinder the development of innovative design ideas.

Approach

This research will develop tools for the hydraulic evaluation of locks and dams. Primarily, the effort will be directed toward the extension of the U.S. Army Corps of Engineers' computational modeling capability. Particular consideration will be given to accurately modeling the components of the filling and emptying system, including the intakes, culverts, valves, chamber manifolds, and outlets. Culvert shape and size and port shape, size, and spacing will be investigated in order to develop design guidance for lock manifolds. The result will be a modeling system that can simulate unsteady processes such as valve movement, lock filling and emptying, and hawser forces on tows during lock operations. This modeling method will be applicable to hydraulic structures in general, but particular attention will be paid to the modeling of locks and dams – the entire system as well as isolated components such as valves, manifolds, and emergency bulkheads.

Products

The product resulting from this research will be a comprehensive method that provides accurate solutions to the unsteady flow in lock filling and emptying systems. The models within this method will be capable of reproducing moving valves and hawser forces on tows moored in the chamber. Technical transfer will be accomplished with papers, technical notes, and technical reports. Guidance on determining dimensionless coefficients that are needed to calculate the flow in manifolds will be provided. Workshops will provide field engineers with updated hydraulic design guidance for locks and dams.

Benefits

Hydraulic engineers will use these design tools to increase hydraulic efficiency of lock filling and emptying systems, minimizing lockage time and maximizing safety of vessels moored in lock chambers. A comprehensive modeling system will reduce unscheduled outages, and improve environmental stewardship at Corps projects. This research will reduce the time and costs required to thoroughly estimate hydraulic performance of navigation locks and dams. Numerical models capable of computing hydrodynamic loads on piers, guard walls, culvert valves, tainter gates, and moored vessels will advance the Corps' ability to provide cost-effective structural, mechanical, and geotechnical designs.

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